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FUNCTIONAL OUTCOME OF VOLAR LOCKING PLATES AND SCREWS IN TREATING INTRA-ARTICULAR FRACTURES OF THE DISTAL RADIUS: A RETROSPECTIVE STUDY.

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Abstract.

Introduction:

For unstable radius distal fractures, to promote rapid recovery of wrist function, Volar locking plates are used widely. It has been noted that volar plate presence near the watershed line is associated with tendon discomfort, and it was advised to avoid implant prominence in this region.

Aim of the Study: To determine which method is more effective in treating wrist or hand fractures, a Synthes 2.4 mm LCP or an Acumed Acu-Loc VLP.

Materials & Methods:

All patients with a Synthes 2.4 mm LCP or an Acumed Acu-Loc VLP of 4 years were reviewed in a follow-up study. The lunate fossa joint line was 10 millimeters from the pattern of the marginal distal radius fracture. The results were evaluated, including motion range, grip strength, and reported pain levels.

Results:

Eighty-four patients met the requirements for inclusion. 42 patients received care using the method of Synthes 2.4 mm LCP, while 42 patients received care using Acumed Acu-Loc VLP. The main result showed that the latter results of the Acu-Loc VLP group had significantly better post-operative range of motion (P = 0.016) and grip strength (P = 0.014). Acu-Loc VLP participants also had significantly higher MAYO wrist scores (P = 0.006).

Conclusion:

If properly and carefully positioned in the position for which it was intended, we think the Acumed Acu-Loc VLP produced superior results than the Synthes 2.4 mm LCP

Recommendation:

Despite implant improvements, distal radius VLP ORIF still causes flexor tendon irritation or rupture. When properly positioned, the Acumed Acu-Loc VLP beat the 2.4 mm LCP synthesis design in functional results. Treating marginal distal radius fractures with this insertion improves patient satisfaction.

Keywords: Volar Locking Plate (VLP), Functional outcome, Distal radius fracture, Intraarticular fracture, Fragment fracture Introduction, Submitted: 2023-09-22,Accepted: 2023-09-26

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1. INTRODUCTION.

Distal radius fractures are frequent and are thought to cause 17-18% of all fracture diagnoses [1, 2]. These fractures must be reduced because two-thirds are displaced. Many different types of treatment have been recommended, and decisions are primarily made depending on the type of fracture [3].

Bridging external fixation is a surgical procedure that can be used. Ligamentotaxis is used in this technique to achieve and maintain fracture alignment [4]. However, open reduction and internal fixation (ORIF) have gained popularity over surgical reduction since locking plates were invented [5]. This procedure offers a quick, stable fixation that enables early mobilization, improves function restoration, and may hasten healing [6].

Contrarily, bridging external fixation augmented is less strenuous, intrusive, and quicker (with or without extra Kirschner wires). Both approaches have been shown to produce excellent results [7]. However, no published data supports ORIF or the alternative, which covers the bridging external fixation of a volar locking plate [8-9].

Fast fragment fracture reduction has many benefits; fixation with stability and early postoperative physical therapy allow for an early return to work and range-of-motion restoration when using volar locking plates [10]. Compared to dorsal plating, the problems with volar locking plates are minor. When compared biomechanically to non-locking structures, the volar locking plate appears more stable and can even hold the dorsally displaced fragment.

Due to its secure immobilization, quick recovery of wrist function, and early postoperative mobility, the volar locking plate (VLP), invented in 2000, is frequently utilized [11]. However, a patient is also at risk for several problems due to distal radius VLP. Between 5 and 27% of patients will experience distal radius VLP fixation issues, including tendonitis, Rupture, malunion, intra-articular screw trajectory, incorrect plate location, and visible hardware [12].

1.1. *Aim of Study.*

- *To determine which method is more effective in treating wrist or hand fractures, a Synthes 2.4 mm LCP or an Acumed Acu-Loc VLP.*

2. MATERIALS AND METHODS.

All patients with an Acumed Acu-Loc VLP, 2.4 mm LCP from Synthes, were examined in this retrospective study in a tertiary care center in Bihar, India. The fracture pattern must extend over the watershed line for the shattered fragment to be held in place by a conventional distal radius VLP. Both implants must meet these requirements. The surgeon preferred using an Acumed Acu-Loc VLP or a Synthes 2.4 mm LCP.

2.1. *Study population.*

It was established that a total of 84 patients had four years' worth of appointments. The study included patients older than 20 at the time of the fracture. It was amenable if their fracture pattern met the diagnostic standards for a marginal distal radius fracture during the twenty-four-month follow-up period. The study excludes patients with central wrist tendon or neurovascular structure injuries, open fractures, multiple fractures, multiple injuries, past wrist injuries on either the ipsilateral or contralateral side, unfollowed within 24 months of surgery, numerous injuries, multiple fractures, and multiple injuries.

Situated over the flexor carpi radialis tendon region, 35 to 45 millimeters above the wrist's volatile side, hand surgeons treated this area using the conventional, modified Henry approach. The cut in the muscle called the pronator quadratus recovered to reveal the site of fracture before the plate's placement. After the procedure, the patients were instructed to start hand active ROM early with strength. Removal of suture before the first follow-up examination and a short arm splint was used to immobilize the joint of the wrist for

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approximately ten days. Passive wrist ROM exercises were performed without weight bearing after removing the short arm splint. This continued for as long as the patient felt comfortable. Six weeks after surgery, passive ROM degrees steadily increased to the point where active ROM was attempted.

A hand surgeon and a senior orthopedic resident assessed the fracture structure and pattern's radiological classification. Based on anteroposterior (AP) film. A marginal radial distal fracture arrangement along a fracture line horizontally was found ten millimeters from the joint line of the lunate fossa. We eliminated straightforward volar or dorsal Barton fracture forms. The pre-operative computed tomography (CT), intra-operative arthroscopic photographs, post-operative plan films, and intra-operative arthroscopic photographs (if Arthroscopic evaluation and documentation of internal fixation and reduction).

Pain levels VAS scores reported by patients, wrist motion, and strength in grip in comparison to the uninjured were the primary results at a doctoral evaluation greater than 2 years post-therapy. The wrists were divided into five groups using the patient's stated motion range and force of grip, each containing 0–24%, 25–49%, 50–74%, 75–99, and 100% of wrists without injury. Patients judged subjectively how well their damaged wrists and hands performed in daily activities like work, sports, and social interactions.

Additionally noted were the Mayo Wrist rating and the necessity for a second round of therapy due to hardware issues, including hardware disposal, tendon announcement, ligament irritation, repairs to the tendon because of tear, reduction loss, or improper plate or screw positions. Hand surgeons performed every fixation and arthroscopy procedure without taking outcome assessments or statistical analysis into account.

2.2. Statistical Analysis.

We represent data using the mean and the standard deviation (SD). The group's comparison was done using non-parametric checking. $P<0.05$ was used to determine whether a statistic was significant.

3. RESULTS.

Synthes 2.4 mm LCP treatment was given with marginal distal radius fractures to 114 patients who met the requirements for four years, but 16 of them were cut off from further analysis because they were patients who could not communicate properly, had initial dual-plating surgery, had lost contact with the study's researchers within 24 months, or were unable to report their functional outcomes because of dementia.

Six patients had simultaneous bilateral distal radius fractures; two were within 24 months after an externally fixed radial artery anastomosis, lost to follow-up of the harm, and two had dual plating initially applied. 14 of the 56 patients who received Acumed Acu-Loc VLP treatment were disqualified from further investigation.

In total, 84 patients met our inclusion criteria; males made up 45.2% of the group, and females made up 54.8%. The fractures weren't all visible. The patients' ages ranged from 23 to 91. At the time of the injury, the average age was 51.19. For the treatment of 42 patients, the Synthes 2.4 mm LCP and Acumed Acu-Loc VLP were employed. According to the forms and patterns of the fractures, 28 patients with extra-articular, and 56 people with of full articular fractures. The distance between the lunate fossa and the horizontal fracture line at the farthest point on AP film ranged from 6.2 to 9.9 mm, with an average of 8.33 mm (Table 1).

22 patients with mixed injuries were reported to have ulnar styloid avulsion fractures. Two of these individuals did, however, get tension band wire therapy. During the volar plating surgery, the hand surgeon additionally evaluated the stability of the DRUJ. DRUJ pinning was necessary for four of the patients. During arthroscopic assist reduction and fixation, it was discovered that Patient 2 had a traumatic tear of the TFCC. This patient was taken care of with suture anchors. On their pre-operative CT and X-ray, eight patients had die-punch fractures.

Table1: **Functional results categorized after a minor distal radius fracture were ftxed with 2 widely utilized VLP's (volar locking plates)**

	Overall	Plate Synthes 2.4 LCP	Acumed Acu-Loc VLP	P value
Age	51.2 (23–91)	51.5 (25–84)	50.8 (23–91)	0.89*
Gender				
Male	38	22	16	
Female	46	20	26	0.53**
AO Fracture Type				
A	28	12	16	
B	0	0	0	0.33**
C	56	32	24	
Mean Marginal Distance (± SD)	8.2 mm (± 0.94)	8.5 mm (± 0.87)	8.3 mm (±0.87)	0.35*
The patient requested to remove the Implant	12	8	4	0.66**

**(Fisher exact test),
*(Mann-Whitney U-test)
(Marginal Distance: The distance between the lunate fossa and the farthest fracture line on the pre-op AP plan film)

At the most recent follow-up, over two years after the surgery, all 84 patients had successfully achieved bone union. All our patients in this study were categorized as per Soong grade II pattern of peripheral distal radius fracture, radial inclination angle, Radial height, volar tilt angle, and ulnar variance, which are radiological parameters that vary little across the groups. In contrast to Two of the forty-two individuals in the Acumed Acu-Loc VLP group, 4 out of 42 patients in the Synthes 2.4 mm LCP group had an articular step-off greater than 2 mm. While using the Synthes 2.4 mm LCP and Acumed Acu-Loc VLP, however, 6 of 42 & 8 out of 42 patients, respectively, experienced statistically insignificant articular between 1 and 2 millimeters (Table 2).

4. DISCUSSION.

Patients included in this survey underwent one of 2 distinct distal radii VLP designs the severe horizontal line of fracture within 10 mm of the lunate fossa for marginal distal radius fractures. Instead of developing fracture setups that required a wider distance from the placement of the plate, mainly for crossing the watershed line, the most extensively used "volar plating systems" (VLP) were developed for fractures extremely close to the joint. Orbay proposed the concept of a watershed line. After some time, Nelson and Orbay finally identified it as the theoretical line marking the most volar aspect of the volar margin of the radius [11]. The transverse ridge's volar radius constrains the concave surface. Numerous comprehensions of the watershed line have been proposed, including the starting point of the ligaments in various places, including the pronator quadratus muscle's distal end [12, 13]. Uncommonly understood is the idea of the watershed line.

To avoid flexor tendon, a condition called dissection, and discomfort, the watershed line is usually used as a proximal indicator for setting the distal radius volar plating. Despite the uncertainty of these definitions, this is true. The watershed line by Soong et al. is the most prominent portion of the volar surface of the distal part of the radius, where the flexor tendon lies closest to the plate and bone [13].

Drobetz and Kustscha-Lissberg et al. claim

Table 2: **Functional results after two widely used volar locking plates were utilized to treat a minor distal radius fracture.**

	Overall	Plate Synthes 2.4 LCP	Acumed Acu-Loc VLP	P value
Radiological parameters				
Radial Height (± SD)	9.48 mm (±1.40)	9.41mm (±1.60)	9.54mm (±1.20)	0.76*
Radial Inclination Angle (± SD)	18.64° (±3.68)	19.09° (±4.02)	18.21° (±3.36)	0.44*
Ulnar Variance (± SD)	0.01mm (±1.96)	−0.01mm (±2.13)	0.04mm (±1.82)	0.92*
Articular step-off (AP view)				
< 1 mm	64	32	32	
1-2 mm	16	6	8	
> 2 mm	4	4	2	
Volar Tilt Angle (± SD)	5.21° (±5.46)	4.75° (±5.32)	5.67° (±5.69)	0.59*

* Fisher exact test; ** Mann-Whitney U-test

that 12 percent of volar plating patients and a designed device allegedly experienced FPL rupture [14]. These authors employed Soong Grading to pinpoint the volar plate to discuss the clinical ramifications of watershed lines for flexor tendon diseases. The distal radius VLP was discovered on surgical transverse views in Soong Grade I or II, which are linked to an increased prevalence of issues in flexor tendons, including tendon friction, unraveling, and rupture [15].

In contrast, the Volar Plate for The Acumed Acu-Loc Wrist Plating System was developed using data from the general public. most recent distal radius anatomy module. The distal edge's precontoured design is more intricate and durable. It also has a low profile, a beveled design, and a circular plate edge. Contrary to the manufacturer's assertion that it is designed to be placed more distal than many other volar plates, it has been noted that its design is most appropriate for the watershed line (cadaver research) [16].

5. CONCLUSION.

Flexor tendon irritation or rupture following distal radius VLP ORIF remains a severe complication despite advancements in implant design. The VLP should typically not be located near the watershed line, and lateral views should limit its volar prominence. However, comminuted or marginal patterns of intra-articular fracture necessitate distal repair, necessitating implant placement farther from the watershed line. When placed into its designated position carefully and accurately, the Acumed Acu-Loc VLP outperformed the 2.4 mm LCP synthesis design regarding superior functional outcomes. Marginal distal radius fractures should be treated, and this insertion promotes patient satisfaction.

6. LIMITATION.

Various studies are carried out in this domain however, the findings of some studies are in contradiction with our study. So more studies are required to affirm the findings of our study.

7. RECOMMENDATION.

Despite implant improvements, distal radius VLP ORIF still causes flexor tendon irritation or rupture. The VLP should be further from the watershed line and seem less volar in lateral views. Comminuted or marginal intra-articular fractures

need distal repair and implant placement away from the watershed line. When properly positioned, the Acumed Acu-Loc VLP beat the 2.4 mm LCP synthesis design in functional results. Treating marginal distal radius fractures with this insertion improves patient satisfaction.

8. LIST OF ABBREVIATION.

VLP- volar locking plate
ORIF- open reduction and internal fixation
AP- anteroposterior
CT- computed tomography
SD- standard deviation
LCP- Locking compression plate

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10. CONFLICT OF INTEREST.

The author had no conflict of interest.

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